MONNIT™

Monnit Wireless Sensors
Serial MODBUS (RTU/ASCII) Gateway

# User's Guide

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# 1.0 Serial MODBUS Gateway Overview

The Monnit Serial MODBUS Gateway (SMG) acts as a data concentrator for Monnit wireless sensor networks. This device allows you to connect up to 100 wireless sensing devices, per gateway, to your existing serial MODBUS RS-232C and RS-485 sensing and control infrastructures.

Monnit has recognized the importance of using open standards like MODBUS, allowing Monnit wireless sensors to be used in the majority of industrial applications. MODBUS is often used to connect a supervisory computer with a remote terminal unit (RTU) in supervisory control and data acquisition (SCADA) systems. MODBUS allows for communication between many (approximately 247) devices connected to the same wired network. Therefore, Monnit SMG's allows for seemingly unlimited wireless expansion of a traditional wired network.

A system incorporating a Monnit SMG would consists of the the following:

- MODBUS Master – PLC, SCADA, etc.
- Existing RS-232C or RS-485 Infrastructure.
- Monnit Serial MODBUS Gateway (SMG).
- Monnit Wireless Sensors

Contains FCC ID: ZTL-RFSC1 & IC: 9794A-RFSC1

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference and (2) this device must accept any interference received, including interference that may cause undesired operation.

*This device has been designed to operate with an approved antenna listed on page 11, and having a maximum gain of 5.1 dBi. Antennas not included in this list or having a gain greater than 5.1 dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.*

*To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that required for successful communication.*

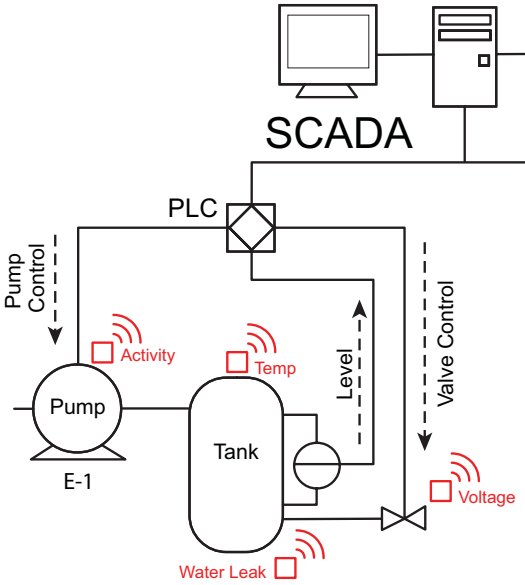
***FCC Approval (USA)** - Refer To Page 34 for FCC Requirements.*
***IC Approval (Canada)** - Refer To Page 35.*

## Features

- Works with Monnit 900, 868 and 433MHz Sensor Networking Solutions
- Communicates with MODBUS RTU / ASCII Protocols
- Supports RS-232C / RS-485 Interfacing
- 3 LED Indicators (System, Wired and Wireless)
- NEMA 4X / IP65 Rated Enclosure
- RP SMA Antenna Connector (Antenna Included)

## Example Network Integration

Monnit wireless sensors integrate with existing MODBUS systems allowing for additional environmental variables to be monitored.



Over 30 unique types of wireless sensors designed to monitor various environmental conditions.

| Monnit Serial MODBUS Gateway Specifications | |
|---|---|
| **General** | |
| Monnit APN Interface Support | RFSC1 Module by Monnit<br>Frequencies: 433, 868 and 900 MHz<br>(Future support for WiFi and 500 mW modules) |
| Antenna | Connector: SMA<br>Gain: 3.0 dBi Standard |
| | |
| **3 Wire Communication Interface** | |
| RS-232C | TXD (OUT), RXD (IN), and Ground / Common |
| RS-485 | D+, D-, and Ground / Common |
| Protocol Selector | Switch for RS-232 and RS485 |
| | |
| **Power** | |
| Input Voltage Range | 5.5 - 36.0 VDC |
| Minimum Current Required | 100mA (500mA Recommended) |
| | |
| **Mechanical** | |
| Reset Feature | Communication / Factory Settings Reset Jumper |
| Enclosure | Durable, Impact-Resistant UV Stabilized Polycarbonate (IP65 of IEC 529 and NEMA 1, 2, 4, 4x, 12 and 13 Rated) |
| Dimensions | 179.603 x 90.678 x 41.30 mm |
| Weight | 16 ounces |
| | |
| **Environmental** | |
| Operating Temperature | -40 to +85 °C (-40 to +185 °F) |
| Storage Temperature | -40 to +85 °C (-40 to +185 °F) |

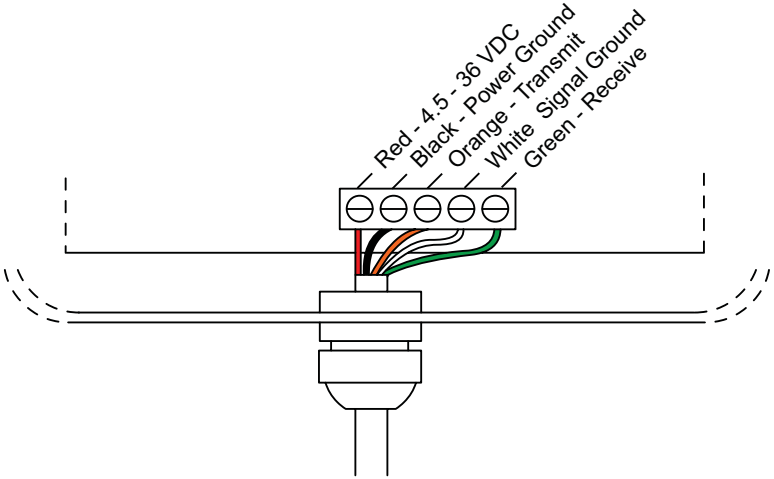
## 2.0 Connecting the Gateway Hardware

This sections contains details on how to connect the Serial MODBUS Gateway (SMG) for testing and use.

The SMG has an interface protocol switch. UP is RS-485. Down is RS-232C.

The SMG has a 5 wire connector already installed and ready for connection. The table below shows the wire mapping.

| SMG 5-Wire Connector | |
|---|---|
| Red: | 4.5 – 36VDC |
| Black: | Power ground |
| Orange: | RS-232C: TXD gateway's transmitter data connection. Connect the MODBUS master's receiver.<br><br>RS-485: D+ Non-inverting 485 transmitter/receiver. |
| White: | Signal ground, internally connected to power ground. |
| Green: | RS-232C: RXD gateway's receiver data connection. Connect the MODBUS master's transmitter.<br><br>RS-485: D- Inverting 485 transmitter/receiver. |



## 3.0 MODBUS Protocol Implementation

See http://modbus.org/docs/Modbus_Application_Protocol_V1_1b.pdf for details on the official protocol and function code.

The Serial MG supports 2 transmission modes: RTU and ASCII.

MODBUS Interfaces will support the following commands: (FC refers to MODBUS Function Codes).

- FC = 1: Read Coils
- FC = 5: Write Single Coil
- FC = 15: Write Multiple Coils
- FC = 3: Read Holding Registers
- FC = 6: Write Single Register
- FC = 16: Write Multiple Registers

All other commands, exceptions, or other interface features are not supported.

## 3.1 Register Size

MODBUS permits the use of a variety of register size specifications. This device uses the standard 16-bit unsigned integer for its register size. Additionally, register-data representation can take the form of multi-register data types (i.e. 32-bit interger). These will be specified specifically for all registers that require additional formatting.

## 3.2 Multi-byte Formatting

MODBUS has specified the use of 'Big-Endian' representation for addresses and data items. This means that when a numerical quantity larger than a single byte is transmitted, the most significant byte is sent first.

## 3.3 Communication Defaults

- Modbus slave ID or Modbus address: 240 or 0xF0
- Modbus-RTU, 8 data bits, No Parity, 1 Stop bit (8-N-1), 19200 baud

## 3.4 Communication Settings Reset Jumper

MUST OPEN ENCLOSURE TO ACCESS

If the device's communications settings are unknown, it is possible to reset the communication settings by placing a jumper on the RESET jumper position when the gateway is not powered. This jumper is scanned at power up or reset.

- Open jumper: Normal operation, Wireless and MODBUS communications allowed to function.
- Closed jumper: Communications interface reset.

If the jumper is detected closed, the device must be power-cycled, with the jumper in the open position, before the device is allowed to operate normally.

## 3.5 Factory Reset

MUST OPEN ENCLOSURE TO ACCESS.

While in communication reset state, if the device remains powered and the reset jumper is deliberately removed and replaced twice, a factory reset will occur on the device. Again, the device must be power-cycled, with the jumper in the open position, before the device is allowed to operate normally.

**NOTE:** a factory reset will remove all known sensors and settings from the device.

## 4.0 Using the Gateway - Coil and Register Map

This device has various coils and registers that allow the user to access gateway and wireless device feature. Here is a brief listing of the accessible coil and register map.

| Resource Name | Acronym | Address |
|---|---|---|
| Gateway Coils | GWC | 0-5 |
| Fast Read Exception Coils (100 total) | FREC [0] thru FREC [99] | 1000-1099 |
| Wireless Device Coils (100 total sets of 5 coils) | WDC [0] thru WDC [99] | 2000-2499 |
| Gateway Registers | GWR | 40000-40022 |
| Wireless Device List (100 total sets of 2 registers) | WDL [0] thru WDL [99] | 41000-41199 |
| Fast Read Registers (100 total sets of 4 registers) | FRR [0] thru FRR [99] | 41200-41925 |
| Wireless Device Registers (100 total sets of 100 registers) | WDR [0] thru WDR [99] | 50000-59999 |

Please see the reference section for more detailed information.

## 4.1 Verifying that the Wireless is Active

Read the “WACTIVE” Gateway Coil @ address 0. A true coil denotes that the system is configured sufficiently to communicate to wireless device(s). A false coil means the gateway does not have any registered wireless devices (WDL is empty).

## 4.2 Resetting the Gateway

Write the “RST_DEVICE” Gateway Coil @ address 2 to TRUE. The device will reset one second after receiving this command. This resets all non-volatile memory fields (i.e. FREC, FRR, and Gateway Time). Additionally, if any gateway settings (baud rate, MODBUS address, communication mode) were modified, this causes these settings to take effect.

## 4.3 Resetting the Wireless Network

Write the “RST_WNET” Gateway Coil @ address 3 to TRUE. The gateway will take approximately 30 seconds to complete the wireless network reset after the acknowledging this command. No serial commands will be acknowledged during this time. This operation optimizes the RF configurations for best performance and clears out all devices from the WDL. The gateway will not be active until at least one wireless device is registered.

## 4.4 Resetting to Default Communications Settings

Write the “RST_COM” Gateway Coil @ address 4 to TRUE. After setting this coil to true, a device reset command (4.3) must be issued (or power cycling) before any of the new settings will take effect.

Resets the baud rate, mode, and device ID back to defaults, which are respectively: 19200, RTU: 8-N-1, 240.

## 4.5 Resetting the Gateway to Factory Settings

Write the “RST_FACTORY” Gateway Coil @ address 5 to TRUE. After setting this coil to true, the device will reset automatically one second after the write coil command is acknowledged. No manual reset is required.

## 4.6 Viewing and Modifying MODBUS Communication Settings

The BAUDRATE Gateway Register @ 40006 contains the baud rate setting. Encoded options are:

0 : 2400
1 : 4800
2 : 9600
3 : 19200
4 : 38400
5 : 57600
6 : 115200

Example:
Writing a value of 2 to this register will effectively change the baud rate to 9600.

The COMMODE Gateway Register @ 40007 contains the following encoded options:

0 : RTU : 8-N-2
1 : RTU : 8-N-1
2 : RTU : 8-E-1
3 : RTU : 8-O-1
4 : ASCII : 7-N-2
5 : ASCII : 7-E-1
6 : ASCII : 7-O-1

Example:
Writing a value of 2 to this register will effectively change the communication mode to RTU : 8-E-1.

The ADDRESS Gateway Register @ 40008 contains the address used by the MODBUS interface. Values of 1-247 are permitted to be written.

Modification to these registers are applied after a power-cycle or gateway reset sequence.

Please see Ref.4 for more information.

## 4.7 Viewing & Modifying Gateway Time

The TIME_H and TIME_L Gateway Register @ 40009 – 40010 contain a UInt32 representation of time in seconds. If read, this will report current time. If written to, this will set the time. If this field is never set to reference any standard time format, it will represent the time from last Gateway reset. It is traditional to set these registers to reflect UNIX time or the number of seconds that have elapsed since January 1st, 1970. However, any custom reference can be used.

## 4.8 Viewing Registered Wireless Devices

The WD_CNT Gateway Register @ 40003 contains the number of registered devices in the Wireless Device List (WDL). A Value of 0 here denotes that no devices are registered and the wireless is disabled.

The WDL consists of 100 set of 2-paired registers that represents the Serial Identifier (SID) for the register device.

These registers can be read to discover the location of a specific device in the list (WDL_SLOT). If any of these registers are written to, the corresponding device entry will be erased and these registers will be zeroed-out.

Please see Ref.5 for more information.

## 4.9 Adding a Wireless Device to the Gateway

Each Monnit device had a 32-bit serial identifier (SID) and a 6 digit verification code. Write to the following registers and coil to add a new wireless device to a gateway.

- Registers WDREG_ID_H and WDREG_ID_L @ 40015-40016 need to be loaded with the wireless devices SID.
- Registers WDREG_CODE_1 through WDREG_CODE_6 @ 40017-40022 need to be loaded with the 6-digit check code. The format of these entries is the ASCII charactor followed by an ASCII null-terminator (“\0” or decimal value of 0)

Example:  SID: 5005145, CODE: “IMARVD”

- WDREG_ID_H = 0x004C
- WDREG_ID_L = 0x5F59
- WDREG_CODE_1 = “I\0” → 0x4900
- WDREG_CODE_2 = “M\0” → 0x4D00
- WDREG_CODE_3 = “A\0” → 0x4100
- WDREG_CODE_4 = “R\0” → 0x5200
- WDREG_CODE_5 = “V\0” → 0x5600
- WDREG_CODE_6 = “D\0” → 0x4400

Then write a true to the REG_DEVICE_NOW Gateway Coil @ 6 to verify that the ID and CODES were input correctly and to add the wireless device.  If successful, the coil write will also be successful.  If the codes are incorrect, the coil write will return a “Modbus IO error message”.

If registering the first wireless device, wait 30 seconds before adding additional devices.

Please see Ref.4 for more information

## 4.10 Verifying Wireless Device Activity

After a device is registered, the slot or index it was registered at can be found by reading the WDL.  Once the slot is know, a user can read the WDC[WDL_SLOT], WDR[WDL_SLOT], FREC[WDL_SLOT], and FRR[WDL_SLOT] associated with the wireless device.

If a wireless device is registered, but is not actively communicating, The FREC[WDL_SLOT] coil will be true.  Additionally, the ACTIVE coil @ WDC[slot] + 0 will be false.

When a wireless device is actively communicating, the ACTIVE coil @ WDC[WDL_SLOT] + 0 will be true and the FREC[WDL_SLOT] coil will reflect the wireless device’s actual exception state.

## 4.11 Viewing Wireless Device Data (Fast Read Method)

All Monnit Wireless Device have two pieces of commonly useful data :

1) if a threshold is breached or if the device is in and exception state
2) the acquired data measurement.

Using the FREC and FRR, a user can quickly collect new data generated by multiple devices registered on the gateway. The purpose of these coils and registers is to allow for efficient access to the remote wireless device's most current exception status and data.

When new data is available from any Wireless device the DATA_READY gateway coil @ 1 is set. This is a quick way to ascertain if there is any new data available in the FRR and FREC.

To get the exception data, read the FREC[WDL_SLOT]. This is a READ-ONLY table. A TRUE (1) coil represents that this specific device is currently in an exception state (OFFLINE, or Reporting an Alert State).

ADDRESS FORMULA = 1000 + WDL_SLOT

Please see Ref.2 for more information on these coils.

The actual data delivered by the sensor can be quickly read by scanning the FRR. Any write to the first address in the FRR will zero out the latest measurement and time. These records consist of four(4) registers per wireless device. The format of these records are: TIME_H, TIME_L, DATA_H, DATA_L.

ADDRESS FORMULA = 41200 + (4*WDL_SLOT)

Please see Ref.6 for more information on these registers.

## 4.12 Viewing Wireless Device Data (Advanced method)

For a user to see more data about a devices exception and activity status, the ACTIVE coil @ WDC[WDL_SLOT] + 0 and EXCEPTION coil @ WDC[WDL_SLOT] + 1 can be queried.

ADDRESS FORMULA for WDC[WDL_SLOT] = 2000 + (5*WDL_INDEX) + Offset

Please see Ref.3 for more information on these coils.

For a user to see the detailed data from a device, read register WDR[WDL_SLOT], offset 5 – 17. This will return last time of measurement, device battery voltage, signal strength, and specific status and data from the device.

Please see Ref.7 for more details on these registers.

## 4.13 Configuring Wireless Devices (Standard Requests)

For a user to view and modify wireless device settings, read/write to register WDR[WDL_SLOT], 18-25. These registers contain information and settings relating to communication intervals, retry, and failure recovery behaviors.

Please see Ref.7 for more details on these registers.

After changes are made to these registers, the user can use the PENDING_CFG coil @ WDC[WDL_SLOT] + 2 to check the status of these changes. When this coil is true, the pending changes have not been communicated with the wireless device. When this coil is reset to false, the wireless device has been updated with the change. We recommend 1 update at a time.

## Reference Section

## Complete Gateway Features and Resource Mapping Reference

Through the Modbus interface, the following features are available for access by a modbus master. All coils and registers are available for read or write access through the MODBUS address mapping presented here.

## Ref.1 - Gateway Coils

The following table represents the supported gateway specific coils. These are intended to report the status, control the state, or trigger events on the gateway.

| Coil Name | Address | Description |
|---|---|---|
| WACTIVE | 0 | True (1) denotes that the system is configured sufficiently to communicate to the sensor.<br><br>False (0) denotes that the Wireless system is not active.<br><br>Causes for this include:<br><br>• No Registered Sensors. |
| DATA_READY | 1 | True (1) denotes that new data has been written to the FRR.<br><br>False (0) denotes that no new data has been written to the FRR.<br><br>FRR(Fast Read Records)– a contiguous sensor data report block. |
| RST_DEVICE | 2 | Writing True (1) to this coil will force a device reset and cleans out all current status. Always read as False (0). |

| | | |
|---|---|---|
| RST_WNET | 3 | Writing True (1) to this coil will force a Wireless Network Reset and reform the operating network setting based on CHANM and NETID (in Gateway Registers). Always read as False (0). |
| RST_COM | 4 | Writing True (1) to this coil will force the ADDRESS, COMMODE, and BAUDRATE to defaults. Always read as False (0). After setting this coil to true, a device reset command must be issued before any of the new settings will take effect. |
| RST_FACTORY | 5 | Writing True (1) to this coil will force all settings to Factory defaults. Always read as False (0). After setting this coil to true, the device will automatically reset so the new settings will take effect. |
| REG_DEVICE_NOW | 6 | Writing True (1) to this coil will cause the register values located in WDREG_ID_H/L and WDREG_CODE1/2/3/4/5/6 to be evaluated. If the values are correct, the device specified will be added to the Wireless Device List at the next available slot. Always read as False (0). |

## Ref.2 - Fast Read Exception Coils (FREC)

The purpose of these coils is to allow for efficient access to the remote wireless device's most current exception status. This is a READ-ONLY table. A TRUE (1) coil represents that the specified device is currently in an exception state (OFFLINE, or Reporting an Alert State).

ADDRESS FORMULA = 1000 + WDL_SLOT.

Example:

| Coil Name | Address | Coil Name | Address |
|---|---|---|---|
| FREC [0] | 1000 | FREC [99] | 1099 |

## Ref.3 - Wireless Device Coils

This section defines the location and function of all the remotely located coils available for access through the MODBUS interface. Every wireless device as been allotted 5 possible coils. The table below enumerates the address allotment.

ADDRESS FORMULA = 2000 + (5*WDL_INDEX).

Example:

| Register Name | Address | Register Name | Address |
|---|---|---|---|
| WDC [0] | 2000 | WDC [99] | 2495 |

The following table represents the specific Wireless Device Coils. These are intended to report the status, control the state, or trigger events on the remotely connected devices.

| Coil Name | Offset | Description |
|---|---|---|
| ACTIVE | 0 | True (1) denotes that the remote wireless device is actively synchronized with the gateway.<br><br>False (0) denotes that the device is considered offline by the gateway. No communications have occurred with the devices for **INACTIVITY_TIMEOUT** (in WDR) amount of time value. This is 0 if no devices are registered.<br>**(READ ONLY)** |
| EXCEPTION | 1 | True (1) denotes that device is in an exception state (data threshold breached or sensor state) and the device's wireless report interval is governed by **INTERVAL_EXCEPTION** (in WDR).<br><br>False (0) denotes that no exception state is currently noted on the wireless device. Therefore the wireless report interval is governed by **INTERVAL_STANDARD** (in WDR).<br>**(READ ONLY)** |
| PENDING_CFG | 2 | True (1) denotes that one or more registers have been modified from their original values (located on the remote device).<br><br>False (0) denotes that the no local registers contain configurations that are different from the remote device.<br><br>Writing True (1) to this coil will cause the local configuration parameters contained in the gateway to be sent to the remote device. **(FORCE OVERWRITE)**. Writing False (0) to this coil will be ignored.<br><br>Coil resets automatically when remote configuration changes have been confirmed.<br><br>It is recommended to only make 1 configuration change at a time. |

| | | |
|---|---|---|
| PENDING_CNTL | 3 | True (1) denotes that a Control Message is pending delivery the the remote wireless device.<br><br>False (0) denotes that the no Control Message is pending delivery.<br><br>Writing True (1) to this coil will cause the gateway to send a CNTL message defined by the **CNTL_COMMAND** and **CNTL_DATA_x** registers (in WDR). Writing False (0) will cause any pending message not to be sent.<br><br>No modification to the **CNTL_COMMAND** and **CNTL_DATA_x** registers (in WDR) are permitted while this coil is true. |
| FORCE_REMOTE_SYNC | 4 | Always read as False (0). If set to True (1), then the wireless device's local registers will be cleared and the remote configurations will be retrieved. |

## Ref.4 - Gateway Registers

The following table represents the supported gateway settings and their corresponding properties.

| Register Name | Address | Description |
|---|---|---|
| VERSION | 40000 | Designates the FW Version of the Gateway. **(READ-ONLY)**<br><br>Example Value: 0x3136 (ASCII characters: Version 1.6) |
| ID_H | 40001 | Gateway's globally-unique identifier. **(READ-ONLY)**<br><br>Combine a ID_H and ID_L to form UInt32 number. |
| ID_L | 40002 | |

| | | |
|---|---|---|
| WD_CNT | 40003 | Wireless Device Count – Value that can be read to discover the number of registered sensors are configured to operate on the gateway. A value 0 – 100 is permitted. **(READ-ONLY)**<br><br>Example Value: 0 (no sensors registered, factory reset condition)<br><br>Example Value: 10 (10 Registered device) |
| OP_NETID | 40004 | Operating network identifier used in the wireless system.<br><br>Value of 1 – 254 is permitted **(READ-ONLY)** |
| OP_CHAN | 40005 | Operating channel designator reports the wireless channel in use. Value of 0-25 is permitted **(READ-ONLY)** |
| BAUDRATE | 40006 | Designates the baud rate used by the MODBUS interface. After modifing this register, a gateway reset must be performed before changes can take effect.<br><br>**Value Represented** — **Baud Selected**<br>0 — 2400<br>1 — 4800<br>2 (DEFAULT) — 9600<br>3 — 19200<br>4 — 38400<br>5 — 57600<br>6 — 115200 |
| COMMODE | 40007 | Designates the operating mode used by the MODBUS interface. After modifing this register, a gateway reset must be performed before changes can take effect.<br><br>**Value Represented** — **Meaning**<br>0 — RTU : 8-N-2<br>1 (DEFAULT) — RTU : 8-N-1<br>2 — RTU : 8-E-1<br>3 — RTU : 8-0-1<br>4 — ASCII : 7-N-2<br>5 — ASCII : 7-E-1<br>6 — ASCII : 7-O-1 |

| | | |
|---|---|---|
| ADDRESS | 40008 | Designates the MODBUS Address used in the communications interface. Values range from 1-247. Default value is 240. Modifying this register will result in a gateway reset. |
| TIME_H | 40009 | Current Time Field in seconds. If this field is never set to reference any standard time format, it will represent the time from last Gateway reset. It is traditional to set these registers to reflect UNIX time or the number of seconds that have elapsed since January 1st, 1970. If read, this will report current time. If written to, this will set the time. Default value is 0000:0000 and is loaded at every power on reset. |
| TIME_L | 40010 | |
| NETID | 40011 | The Network ID value represented here is used to configure the wireless network. Default: 0, meaning that the wireless is allowed to scan and use a free network identifier. If value is 1 – 254, the wireless is forced to used the specified value. Do not write a value greater than 254. After this register is modified, the RST_WNET coil must be set to true to reform the network and select new OP_NETID and OP_CHAN settings. |
| CHANM_H | 40012 | The configurable channel mask is a UInt32 bit-field that represents the allowed channels the wireless is allowed to establish a network. Default value contains a 1 for every possible channel (all channels are allowed). If the value is 0x00000011, then the network is only allowed to be established on channels 0 and 4. After these registers are modified, the RST_WNET coil must be set to true to reform the network and select new OP_NETID and OP_CHAN settings. |
| CHANM_L | 40013 | |

| | | |
|---|---|---|
| RESET_CNTR | 40014 | Internal Reset Counter Register. When a standard reset or watchdog event occurs, meaning the device stalled for ~0.9 seconds, a device reset will occur, and this value will be incremented by one. A write to this register will replace the current value with the one specified. |
| WDREG_ID_H | 40015 | Wireless Device's Identification Number of a device that will be registered to the gateway's Wireless Device List. (UInt32 value)<br>Example: 5005145 → _H = 0x004C, _L = 0x5F59. |
| WDREG_ID_L | 40016 | |
| WDREG_CODE_1 | 40017 | A string security code unique to a specific Monnit Wireless Device ID. This value is cross-referenced against the device ID registers to successfully add the device to the gateway's Wireless Device List. Every entry is null terminated ("\0" or decimal value of 0).<br><br>Example: "IMARVD"<br><br>CODE_1 = "I\0" → 0x4900<br>CODE_2 = "M\0" → 0x4D00<br>CODE_3 = "A\0" → 0x4100<br>CODE_4 = "R\0" → 0x5200<br>CODE_5 = "V\0" → 0x5600<br>CODE_6 = "D\0" → 0x4400 |
| WDREG_CODE_2 | 40018 | |
| WDREG_CODE_3 | 40019 | |
| WDREG_CODE_4 | 40020 | |
| WDREG_CODE_5 | 40021 | |
| WDREG_CODE_6 | 40022 | |

## Ref.5 - Wireless Device List Registers

The WDL register store the serial identifier of the registered wireless devices. The serial identifiers are formatted as a UInt32, therefore two contiguous registers must be read to extract the full value.

ADDRESS FORMULA = 41000 + (2*INDEX)

List entries can be as follows:

0xFFFFFFFF: EMPTY
0x00000000: ERASED, Unusable until a Network Reset
Otherwise, a real device is registered

Example:

| Register Name | Address | Register Name | Address |
|---|---|---|---|
| WDL [0] | 41000 | WD [99] | 41198 |

## Ref.6 - Fast Read Registers

The purpose of these registers is to allow for efficient access to the remote wireless device's most current data. Any write to the first address in the FRR will zero out the latest measurement and time.

These records consist of four(4) registers per wireless device.

ADDRESS FORMULA = 41200 + (4*WDL_SLOT)

Example:

| Record Name | Address | Record Name | Address |
|---|---|---|---|
| FRR [0] | 41200 | FRR [99] | 41596 |

The format of these records are:

| Field Name | Offset | Description |
|---|---|---|
| TIME_H | 0 | The System Time that the following data was posted to the FRR. A write to offset 0 will zero out the entire record. |
| TIME_L | 1 | |

| | | |
|---|---|---|
| DATA_H | 2 | Data generated by wireless device. The format for this data can be found in the Monnit Serial MODBUS Sensor Application Definition document. |
| DATA_L | 3 | |

## Ref.7 - Wireless Device Registers

This section defines the location and function of all the remotely located registers available for access through the MODBUS interface. Every wireless device as been allotted 100 possible registers. The table below enumerates the address allotment.

ADDRESS FORMULA = 50000+(100*WDL_INDEX)

Example:

| Register Name | Address | Register Name | Address |
|---|---|---|---|
| WDR [0] | 50000 | WDR [99] | 59900 |

The following table represents the supported Wireless Device Registers. They contain the pertinent data and configurations populated from the remote device. Through these registers, a user is capable of interpreting additional data, setting new configurations, and sending other control-related messages (CNTL) to the remote device. Unknown or unused values are defaulted to 0x0000.

| Field Name | Offset | Description |
|---|---|---|
| ID_H | 0 | Wireless device's globally-unique identifier. Combine a ID_H and ID_L to form full UInt32 number. **(READ-ONLY)** |
| ID_L | 1 | |
| VER_MAJOR | 2 | Wireless device's firmware version number. Registers VER_MAJOR::VER_MINOR to be interpreted as ASCII characters with the following format: "M0"."M1"."m0"."m1".<br><br>Example: VER = 0x3230::0x3136 → "Version: 2.0.1.6". **(READ-ONLY)** |
| VER_MINOR | 3 | |

| | | |
|---|---|---|
| TYPE | 4 | Device Type value that is used to interpret the sensor specific portions of this record. **(READ-ONLY)** See note 1. |
| LAST_COMM_H | 5 | Current Julian date/time value (UInt32) for the last time the remote device reported data. **(READ-ONLY)**. |
| LAST_COMM_L | 6 | |
| VOLTAGE | 7 | Current Voltage reported from the remote device. Value formatted in milli-volts. **(READ-ONLY)**.<br><br>Example: 301 → 3.01 Volts |
| RSSI | 8 | Current Received Signal Strength Indicator. Formatted as Int16. Values of -20 to -106 dBm typical. The less negative the number, the more signal there was on the last communication. **(READ-ONLY)**. |
| STATUS | 9 | Current Status reported from the remote device. **(READ-ONLY)**. See note 1. |
| DATA_0 | 10 | The current data reported by the remote device.<br><br>See Note 1 for and explanation of these registers.<br><br>**(READ-ONLY)**. |
| DATA_1 | 11 | |
| DATA_2 | 12 | |
| DATA_3 | 13 | |
| DATA_4 | 14 | |
| DATA_5 | 15 | |
| DATA_6 | 16 | |
| DATA_7 | 17 | |
| INACTIVITY_ TIMEOUT | 18 | Timeout in 5 min steps. Values of 1 to 216 (5 min to 18 hrs) permitted. If the device has communicated within the amount of time specified here, the ACTIVE coil is set to TRUE. If No communications have occurred with the devices for this specified amount of time, the ACTIVE coil is reset to FALSE. |

| | | |
|---|---|---|
| CFG_ CHANM_H | 19 | Configurable Channel Mask is a UInt32 bit-field that represents the allowed channels the wireless device is permitted to use to search for gateways. If the value is written to 0x00000011, then the network is only allowed to be established on channels 1 and 5. |
| CFG_ CHANM_L | 20 | |
| CFG_INTERVAL_ LINK | 21 | Configurable Interval Link represents the device's link-state sleep time. If the device disconnects from its current network (e.g. failures, reset), it will scan permitted channels for a new link. If no gateway is found, then this specified period of time is waited before attempting to relink. This value is a UInt16 that is interpreted as follows:<br><br>• CFG_LINKHB <= 18, value is in hours. (1-18 HRS)<br>• CFG_LINKHB > 100. value is in minutes. (105 = 5 MIN)<br>• If 0 or Otherwise, 2HR default |
| CFG_ INTERVAL_ STANDARD | 22 | Configurable Interval for Standard Reports is the regular check-in interval for the wireless device (based on timer, not events).<br><br>Format: UInt16 number of seconds to wait before checking in.<br><br>See Notes 1 & 2. |
| CFG_ INTERVAL_ EXCEPTION | 23 | Configurable Interval for Exception Reports is the check-in interval used during exception cases (based on timer, not events).<br><br>Format: UInt16 number of seconds to wait before checking in.<br><br>See Notes 1 & 2. |

| | | |
|---|---|---|
| CFG_ RETRIES | 24 | Configurable Retry Limit represents the number of attempts made by the device to deliver its data when the primary attempt fails. Value of 0 – 10 inclusive are permitted. |
| CFG_ RELINK | 25 | Configurable Relink Limit represents the number of report attempts can fail consecutively before the sensor drops current gateway connection and re-scans for a better connection. Value of 1-10 inclusive are permitted for the relink behavior. If value is 0, then this behavior is disabled and only a power-cycle can reset the device's link settings. |
| CFG_ PROFILE_ TYPE | 26 | Value that selects what profile specific device type is recognized by the remote device. (**READ ONLY** – Write attempts are ignored)<br><br>**INTERVAL–TYPE DEVICE = 1**<br>-- Primarily governed by a timer. When it is time to deliver data, the wireless device transmits the data to the gateway.<br><br>**TRIGGER–TYPE DEVICE = 2**<br>-- Primarily governed by the occurrence of an event. If an event is detect OR the CFG_INTERVAL_STANDARD is reached, then the wireless device transmits the data to the gateway. |
| CFG_INT_TYPE_ MEAS_PER_RPT | 27 | Device-Type Specific Parameter: **INTERVAL–TYPE DEVICE**<br><br>Measurements Per Report represents the number of measurements that will be taken for every given wireless report. If a exception is noted, then the device will immediately report instead of waiting for the report interval. Value of 1 – 250 permissible. Minimum granularity of 1 sec maximum sample rate.<br><br>See Note 1. |

| | | |
|---|---|---|
| CFG_INT_TYPE_ HYSTERESIS_H | 28 | Device-Type Specific Parameter: **INTERVAL–TYPE DEVICE**<br><br>Hysteresis represents the amount of observed variance must occur to permit a device that has registered an exception to remove the exception notification.<br><br>See Note 1. |
| CFG_INT_TYPE_ HYSTERESIS_L | 29 | |
| CFG_INT_TYPE_ THRESH_MIN_H | 30 | Device-Type Specific Parameter: **INTERVAL–TYPE DEVICE**<br><br>Minimum Threshold represents the amount of device specific observed signal can be reduced before an exception is registered and reported.<br><br>See Note 1. |
| CFG_INT_TYPE_ THRESH_MIN_L | 31 | |
| CFG_INT_TYPE_ THRESH_MAX_H | 32 | Device-Type Specific Parameter: **INTERVAL–TYPE DEVICE**<br><br>Maximum Threshold represents the amount of device specific observed signal can be increased before an exception is registered and reported.<br><br>See Note 1. |
| CFG_INT_TYPE_ THRESH_MAX_L | 33 | |

| | | |
|---|---|---|
| CFG_INT_TYPE_ CALVAL_1_H | 34 | Device-Type Specific Parameter: **INTERVAL–TYPE DEVICE**<br><br>Calibration / Control Values.<br><br>See Note 1 for and explanation of these registers. |
| CFG_INT_TYPE_ CALVAL_1_L | 35 | |
| CFG_INT_TYPE_ CALVAL_2_H | 36 | |
| CFG_INT_TYPE_ CALVAL_2_L | 37 | |
| CFG_INT_TYPE_ CALVAL_3_H | 38 | |
| CFG_INT_TYPE_ CALVAL_3_L | 39 | |
| CFG_INT_TYPE_ CALVAL_4_H | 40 | |
| CFG_INT_TYPE_ CALVAL_4_L | 41 | |
| CFG_TRG_TYPE_ DETECT_TYPE | 42 | Device-Type Specific Parameter: **TRIGGER–TYPE DEVICE**<br><br>Mode / Control Values.<br><br>See Note 1 for and explanation of these registers. |
| CFG_TRG_TYPE_ DETECT_PERIOD | 43 | |
| CFG_TRG_TYPE_ DETECT_COUNT | 44 | |
| CFG_TRG_TYPE_ DETECT_REARM | 45 | |
| CFG_TRG_TYPE_ DETECT_BI-STABLE | 46 | |
| CNTL_COMMAND | 47 | CONTROL MESSAGE HANDLING:<br>Command value to send to the remote device.<br><br>When the COMMAND, LENGTH and PAYLOAD values are prepared, then a user sets the PENDING_CNTL Coil to signal the message needs to be delivered to the remote unit.<br><br>See Note 1 for detailed explanation of possible command values. |

| | | |
|---|---|---|
| CNTL_LENGTH | 48 | CONTROL MESSAGE HANDLING:<br>Length of the payload bytes required to be delivered to device.<br><br>When the COMMAND, LENGTH and PAYLOAD values are prepared, then a user sets the PENDING_CNTL Coil to signal the message needs to be delivered to the remote unit.<br><br>See Note 1 for detailed explanation of possible command values. |
| CNTL_PAYLOAD_0 | 49 | CONTROL MESSAGE HANDLING:<br>The specific payload data that needs to accompany the command.<br><br>When the COMMAND, LENGTH and PAYLOAD values are prepared, then a user sets the PENDING_CNTL Coil to signal the message needs to be delivered to the remote unit.<br><br>See Note 1 for detailed explanation of possible command values. |
| CNTL_PAYLOAD_1 | 50 | |
| CNTL_PAYLOAD_2 | 51 | |
| CNTL_PAYLOAD_3 | 52 | |
| CNTL_PAYLOAD_4 | 53 | |
| CNTL_PAYLOAD_5 | 54 | |
| CNTL_PAYLOAD_6 | 55 | |
| CNTL_PAYLOAD_7 | 56 | |
| CNTL_ LAST_STATUS | 57 | The status report of the last CNTL command execution. Success = 0, Error != 0<br><br>See Note 1 for detailed explanation of possible error values. |

**Notes:**

1. See Monnit's Serial MODBUS Sensor Application Definition document for more information on field definitions, enumeration, and usage for these specific registers.
2. An Interval that specifies under 10 minutes must consider the battery power usage and wireless network load the gateway may experience if the CFG_INTERVAL parameters a set too low. It is recommended to keep then network load to at most 10 device reports per minute. The maximum interval for communications is 12 hrs → 43200 seconds.

# Error Reporting, Troubleshooting and Support

For technical support and troubleshooting tips please visit our support library online at http://www.monnit.com/support/. If you are unable to solve your issue using our online support, email Monnit support at support@monnit.com with your contact information and a description of the problem, and a support representative will call you within one business day.

For error reporting, please email a full description of the error to support@monnit.com.

# Warranty Information

(a) Monnit warrants that Monnit-branded products will be free from defects in materials and workmanship for a period of one (1) year from the date of delivery with respect to hardware and will materially conform to their published specifications for a period of one (1) year with respect to software. Monnit may resell sensors manufactured by other entities and are subject to their individual warranties; Monnit will not enhance or extend those warranties. Monnit does not warrant that the software or any portion thereof is error free. Monnit will have no warranty obligation with respect to Products subjected to abuse, misuse, negligence or accident. If any software or firmware incorporated in any Product fails to conform to the warranty set forth in this Section, Monnit shall provide a bug fix or software patch correcting such non-conformance within a reasonable period after Monnit receives from Customer (i) notice of such non-conformance, and (ii) sufficient information regarding such non-conformance so as to permit Monnit to create such bug fix or software patch. If any hardware component of any Product fails to conform to the warranty in this Section, Monnit shall, at its option, refund the purchase price less any discounts, or repair or replace non-conforming Products with conforming Products or Products having substantially identical form, fit, and function and deliver the repaired or replacement Product to a carrier for land shipment to customer within a reasonable period after Monnit receives from Customer (i) notice of such non-conformance, and (ii) the non-conforming Product provided; however, if, in its opinion, Monnit cannot repair or replace on commercially reasonable terms it may choose to refund the purchase price. Repair parts and replacement products may be reconditioned or new. All replacement products and parts become the property of Monnit. Repaired or replacement products shall be subject to the warranty, if any remains, originally applicable to the product repaired or replaced. Customer must obtain from Monnit a Return Material Authorization Number (RMA) prior to returning any Products to Monnit. Products returned under this Warranty must be unmodified.

Customer may return all Products for repair or replacement due to defects in original materials and workmanship if Monnit is notified within ninety (90) days of customer's receipt of the product. Monnit reserves the right to repair or replace products at its own and complete discretion. Customer must obtain from Monnit a Return Material Authorization Number (RMA) prior to returning any products to Monnit. Products returned under this Warranty must be unmodified and in original packaging. Monnit reserves the right to refuse warranty repairs or replacements for any products that are damaged or not in original form. For products outside the ninety-day warranty period repair services are available at Monnit at standard labor rates for a period of one year from the Customer's original date of receipt.

(b) As a condition to Monnit's obligations under the immediately preceding paragraphs, Customer shall return Products to be examined and replaced to Monnit's facilities, in shipping cartons which clearly display a valid RMA number provided by Monnit. Customer acknowledges that replacement products may be repaired, refurbished or tested and found to be complying. Customer shall bear the risk of loss for such return shipment and shall bear all shipping costs. Monnit shall deliver replacements for Products determined by Monnit to be properly returned, shall bear the risk of loss and such costs of shipment of repaired products or replacements, and shall credit Customer's reasonable costs of shipping such returned Products against future purchases.

(c) Monnit's sole obligation under the warranty described or set forth here shall be to repair or replace non-conforming products as set forth in the immediately preceding paragraph, or to refund the documented purchase price for non-conforming Products to Customer. Monnit's warranty obligations shall run solely to Customer, and Monnit shall have no obligation to customers of Customer or other users of the Products.

Limitation of Warranty and Remedies.

THE WARRANTY SET FORTH HEREIN IS THE ONLY WARRANTY APPLICABLE TO PRODUCTS PURCHASED BY CUSTOMER. ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE EXPRESSLY DISCLAIMED. MONNIT'S LIABIITY WHETHER IN CONTRACT, IN TORT, UNDER ANY WARRANTY, IN NEGLIGENCE OR OTHERWISE SHALL NOT EXCEED THE PURCHASE PRICE PAID BY CUSTOMER FOR THE PRODUCT. UNDER NO CIRCUMSTANCES SHALL MONNIT BE LIABLE FOR SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES. THE PRICE STATED FOR THE PRODUCTS IS A CONSIDERATION IN LIMITING MONNIT'S LIABILITY. NO ACTION, REGARDLESS OF FORM, ARISING OUT OF THIS AGREEMENT MAY BE BROUGHT BY CUSTOMER MORE THAN ONE YEAR AFTER THE CAUSE OF ACTION HAS ACCRUED.

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# Certifications

## United States FCC

*This equipment has been tested and found to comply with the limits for a Class B digital devices, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of more of the following measures:*

- *Reorient or relocate the receiving antenna*
- *Increase the separation between the equipment and receiver*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

**Warning:** *Changes or modifications not expressly approved by Monnit could void the user's authority to operate the equipment.*

**RF Exposure**

**WARNING:** To satisfy FCC RF exposure requirements for mobile transmitting devices, the antenna used for this transmitter must not be co-located in conjunction with any other antenna or transmitter.

***FCC ID: ZTL-RFSC1***

*This device has been designed to operate with an approved antenna listed below, and having a maximum gain of 5.1 dBi. Antennas not included in this list or having a gain greater than 5.1 dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.*

*To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that required for successful communication.*

***Approved Antennas***

The following antennas are approved for use with FCC ID: ZTL-RFSC1

- *Hyperlink HG905RD-RSP (5.1 dBi Rubber Duck)*
- *Pulse W1063 (3.0 dBi Rubber Duck)*
- *ChangHong GSM-09 (2.0 dBi Rubber Duck)*
- *Specialized Manufacturing MC-ANT-20/4.0C (4" whip)*

***FCC ID: ZTL-RFUSB1***

*This device has been designed to operate with the attached non-removable antenna.*

## Canada (IC)

***English***

*Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.*

*This radio transmitter (IC: 9794A-RFSC1 and IC: 9794A-RFUSB1) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.*

*This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.*

***French***

*Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.*

*Le présent émetteur radio (IC: 9794A-RFSC1 et IC: 9794A-RFUSB1) a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.*

*Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, méme si le brouillage est susceptible d'en compromettre le fonctionnement.*

For additional information on Monnit Wireless Sensors and Software, please visit us on the web at www.monnit.com.

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